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Original research article

THE INFLUENCE OF CERTAIN ANTHROPOMETRIC PARAMETERS ON THE RESULTS IN LEAD CLIMBING

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Abstract. *The aim of this paper was to determine the influence of certain anthropometric parameters on the results in lead climbing among female (N=15) and male (N=15) senior level climbers in 10 clubs from Serbia. To evaluate the anthropometric parameters the following measurements were taken: body height, arm length, leg length, hand length, hand span and arm span. The results in lead climbing were represented by the highest difficulty grade of a climb achieved during testing. A regression analysis was used to confirm that there was no statistically significant influence of the anthropometric parameters on the results in lead climbing among male and female climbers at the multivariate level, as well as on all the applied variables among the female climbers at the univariate level. However, the significance of individual regression coefficients of the variables of body height, hand length, hand span and arm span indicate that during selection of young competitors it would be worthwhile to take these anthropometric parameters into consideration (smaller body height and hand length, and a wider hand span and arm span). In addition, research is needed into whether there are any significant relations between the parameters of hand length and hand span and the strength of the hand grip and relative strength of the hand grip among sport climbers.*

Key words: *anthropometric parameters, lead climbing*.

INTRODUCTION

Morphological characteristics represent primary information on the psychosomatic status of humans which are determined by the system of basic anthropometric latent dimensions (Gajević, 2009). They describe body build, that is, the somatotype features of humans. Morphological characteristics include the system of certain latent dimensions, irrespective of whether these dimensions have been developed under the influence of endogenic (genetically conditioned or inherited features) or exogenic factors (the quality

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of one's diet, physical activity, resilience of the body, etc.). Morphological dimensions can be defined as a group of anthropometric measurements relevant for studies in physical education, transformed by means of factor procedures into latent morphological dimensions (Perić, 1994).

Considering the study of morphological characteristics of sports climbers, the somatotype is mesomorph-ectomorph (Viviani & Calderan, 1991; Watts, Martin, & Durtschi, 1993; Alvero-Cruz, 2011) or ectomorph-mesomorph (Puletić, 2014), and climbers have a small percentage of body fat (Viviani & Calderan, 1991; Watts et al., 1993; Watts, Joubert, Lish, Mast, & Wilkins, 2003a; Chueng 2009; Tomaszewski, Gajewski, & Lewandowska, 2011; Puletić, 2014). The ape index (ratio between body height and arm span) for climbers of both sexes is greater than one (Chueng 2009; Mitchell, Bowhay, & Pitts, 2011; Tomaszewski et al., 2011) and higher than in the normal population (Tomaszewski et al., 2011). Although they are characterized by specific smaller bodies compared to other athletes, morphological characteristics did not prove to be the dominant faactor affecting the outcome of sport climbing performance (Mermier, Janot, Parker, & Swan, 2000; España-Romero, Ortega Porcel, García-Artero, Ruiz, & Gutiérrez Sainz, 2006; Mihailov, Mladenov, & Schoffl, 2009; Tomaszewski et al., 2011; Stanković, Ignjatović, Puletić, & Raković, 2013). However, Watts et al. (1993) consider that increased ectomorphy and decreased endomorphism represent an advantage in climbing due to a decrease in the overall weight that one works with. In addition, the research carried out by Puletić (2014) determined a statistically significant influence of the components of the somatotype, as well as of some morphological characteristics on the results in sport climbing.

The aim of this paper is to determine the influence of certain anthropometric parameters on the results in lead climbing among male and female climbers.

METHODS

The sample of participants

For this particular study, the sample of participants was extracted from a population of male and female climbers. The sample consisted of 45 participants (30 male and 15 female participants) from 10 clubs in Serbia. The sample included every participant who had previously voluntarily agreed to take part in the study and whose club was a full member of the Mountaineering Association of Serbia or the Sport Climbing Federation of Serbia in 2016. The precondition all the participants had to meet was to be healthy and free of any injury which could prevent them from performing the tests on the day of the testing, and an additional condition was that the minimal difficulty grade of the climb for the season was VI+/VII- (6a).

The average age of the participants was 29.57±6.21, their average body height was 181±6.2 cm, average body mass was 73.10±7.25 kg and their average body mass index was 22.32±1.97. The female participants were aged 27.33±5.16, had an average body height of 168.33±5.8 cm, average body mass of 55.40±6.78 kg and average body mass index of 19.51±1.77. If we were to look at the average values for the greatest difficulty grade of the climb during the testing period, we would notice that the male participants on average had a difficulty grade of VIII and VIII+ (7a/7a+), while the average difficulty grade of the climb for the female participants was approximately VIII (7a).

Measuring instruments

In this study, the following tests were applied to estimate the anthropometric parameters of the sport climbers: body height (TVIS), arm length (DURU), leg length (DUNO), hand length (DUŠA), hand span (RAŠA) and arm span (RARU). The measurements used to evaluate the anthropometric parameters are contained within the International Biological Program (IBP). The lead climbing results are represented by the greatest difficulty grade of the climb during the testing period using the points system of the World Ranking of Sport Climbers (2013).

Statistical analysis

The statistical methods of analyses included the following.

The descriptive statistics comprised: the number of participants (N), mean value (Mean), standard deviation (SD), minimum (Min) and maximum (Max) numerical results, range (Range) and standard error of the mean value (Error). The discriminative measurements were performed by two procedures: Skewness (Skew) pointing to the symmetry of substance layout around the arithmetic mean and Kurtosis (Kurt) designating peakedness or flatness of distribution.

To determine the influence of the predicting variables (anthropometric parameters) on the criterion variable (result in lead climbing), a regression analysis was used. It contains the following parameters: coefficient of correlation (r), coefficient of the partial correlation (Part–r), standardized regression coefficient (Beta), vector of the standardized regression coefficient (t), significance of the beta coefficient (p-level), coefficient of the multiple correlations (R) coefficient of the determination (R2), and the level of the significance of the regression connection on the multivariate level (p).

Raw data were processed by means of the Statistica 10.0 software package. Statistical significance was determined at the level of $p<0.05$.

RESULTS

Table 1 shows the results of the basic central and dispersion parameters of the anthropometric parameters of the male sport climbers. The analysis revealed a good discrimination of the applied tests, since within the range (Range) there are always 3-5 standard deviations (SD) of the appropriate variable. The skewness (Skew) and kurtosis (Kurt) indicate that the data distribution is symmetrical and mesokurtic. Only in the case of the variable of body height (BHEIGHT) and arm span (ARMSPAN) is there a more condensed distribution of data around the means.

Table 1 The basic central and dispersion parameters – anthropometrics, male climbers

Variables	N	Mean	Min	Max	Range	SD	Error	Skew	Kurt
BHEIGHT (cm)	30	181.00	161.00	193.00	32.00	6.199	1.132	-0.962	2.886
ARMLENG (cm)	30	79.40	73.00	86.50	13.50	3.440	0.628	0.216	-0.244
LEGLENG (cm)	30	91.52	80.00	102.00	22.00	5.125	0.936	-0.386	0.298
HANLENG (cm)	30	20.24	18.00	22.50	4.50	1.119	0.204	0.236	-0.672
HANSPAN (cm)	30	22.46	20.00	24.50	4.50	1.285	0.235	-0.332	-0.959
ARMSPAN (cm)	30	184.36	163.00	204.00	41.00	7.498	1.369	-0.163	2.101

By analyzing table 2 which shows the basic central and dispersion parameters of anthropometric parameters of the female climbers, a good discrimination value of all the applied tests can be noted-the range always contains 3-5 standard deviations. The skewness speaks in favor of the symmetric distribution of data for all the applied variables, while the kurtosis is normal (mesokurtic) except for the variable of leg length (LEGLENG) where the distribution is slightly condensed.

Table 2 The basic central and dispersion parameters – anthropometrics, female climbers

Variables	N	Mean	Min	Max	Range	SD	Error	Skew	Kurt
BHEIGHT	15	168.33	157.00	175.00	18.00	5.802	1.498	-0.6324	-0.7911
ARMLENG	15	72.20	67.50	75.50	8.00	2.597	0.670	-0.4472	-0.8457
LEGLENG	15	85.47	74.00	92.00	18.00	4.704	1.214	-0.8808	1.2561
HANLENG	15	18.43	17.00	21.00	4.00	1.116	0.288	0.8150	0.1692
HANSPAN	15	19.73	17.00	23.00	6.00	1.771	0.457	0.4882	-0.1140
ARMSPAN	15	167.60	153.00	183.00	30.00	7.944	2.051	-0.2723	0.3232

No statistically significant influence of the anthropometric parameters on the results in lead climbing for the male climbers was determined at the multivariate level, but the value was borderline significant ($p<0.0623$). The multiple correlation coefficient (R) was 0.618 while the joint variation of the system of predictor and criterion variables was approximately 38% ($R^2=0.382$).

However, the analysis of individual regression coefficients indicates the significant influence of body height (BHEIGHT, p-value=0.0205) and hand length (HANLENG, p-value=0.0446) with a negative value, and hand span (HANSPAN, p-value=0.0314) and arm span (ARMSPAN, p-value= 0.0138) with a positive value. It is interesting that none of the coefficients of the linear correlation of predictor variables (anthropometric parameters) were connected to the criterion (the results in lead climbing) in a statistically significant manner.

Table 3 The influence of anthropometric parameters on the results in lead climbing among the male climbers

Variables	r	Part-r	b	Std.Err. of b	t(23)	p-value
BHEIGHT	0.015	-0.461	-30.051	12.072	-2.489	**0.0205**
ARMLENG	0.079	-0.123	-10.636	17.855	-0.596	0.5572
LEGLENG	0.089	0.322	20.431	12.523	1.631	0.1164
HANLENG	0.062	-0.405	-118.796	55.931	-2.124	**0.0446**
HANSPAN	0.269	0.431	92.414	40.323	2.292	**0.0314**
ARMSPAN	0.247	0.486	26.535	9.954	2.666	**0.0138**
R= 0.618		R^2= 0.382		F(6,23)= 2.374		p< 0.0623

The regression analysis of the influence of anthropometric parameters on the results for lead climbing among the female climbers (Table 4) indicates no statistically significant influence ($p<0.8109$). The multiple correlation coefficient (R) was 0.512 while the joint variation of the system of predictor of criterion variables was approximately 26% ($R^2=0.262$).

Table 4 The influence of anthropometric parameters on the results in lead climbing among the female climbers

Variables	r	Part-r	b	Std.Err. of b	t(23)	p-value
BHEIGHT	-0.222	-0.377	-41.995	36.438	-1.153	0.2824
ARMLENG	-0.128	-0.023	-5.946	89.661	-0.066	0.9488
LEGLENG	-0.144	-0.023	-1.635	25.061	-0.065	0.9496
HANLENG	0.099	-0.170	-83.510	170.942	-0.489	0.6383
HANSPAN	0.174	0.280	97.394	118.253	0.824	0.4340
ARMSPAN	0.013	0.194	19.348	34.622	0.559	0.5916
R= 0.512		R^2= 0.262		F(6,23)= 0.474		p< 0.8109

By analyzing the individual regression coefficients it can be noted that there are no statistically significant regression coefficients. In addition, neither the analysis of the linear (r) nor partial correlation (Part-r) showed a significant connection between the criterion and each individual predictor variable.

DISCUSSION

By analyzing tables 1 and 2 which show the basic central and dispersion parameters of the anthropometric parameters of the male and female climbers we can note a good discrimination value of the applied tests, since within the range (Range) there are always 3-5 standard deviations (SD) of the appropriate variable. When it comes to the symmetric nature of the distribution in relation to the arithmetic means, we might say that the distribution of the data is symmetrical among all the applied variables for the evaluation of the anthropometric parameters among the male and female climbers (tables 3 and 4). The analysis of the density of distribution (kurtosis-Kurt) speaks in favor of normal data distribution (mesokurtic) for most of the applied tests. Only in the case of the variables of body height (BHEIGHT) and arm span (ARMSPAN) for the group of male climbers is there a more dense distribution of data around the means, as well as for the variable of leg length (LEGLENG) for the group of female climbers, where the distribution is slightly more dense.

For the group of male climbers, no statistically significant influence was determined at the multivariate level, but it was borderline significant ($p<0.0623$). The multiple correlation coefficient (R) had a value of 0.618 while the joint variation of the system of predictor and criterion variables was approximately 38% ($R^2=0.382$). These results indicate that morphological characteristics are not a dominant factor which influences the results in lead climbing, which was confirmed in the research of Mermier et al., 2000, España-Romero et al., 2006, Mihailov et al., 2009, Tomaszewski et al., 2011 and Stanković et al., 2013. However, the analysis of individual regression coefficients indicates the significance of the influence of body height (BHEIGHT, p-value=0.0205) and hand length (HANLENG, p-value= 0.0446) with a negative value, and hand span (HANSPAN, p-value=0.0314) and arm span (ARMSPAN, p-value=0.0138) with a positive value. This agrees with the research results of Watts et al. (1993) and Watts et al. (2003), who came to the conclusion that elite sports climbers are of lower to mid stature. It also agrees with the results of Puletić (2014), who determined a statistically significant influence of the components of the somatotype, as well as of certain morphological characteristics on the results of sport

climbing. What is also interesting is that none of the coefficients of the linear correlation of predictor variables (anthropometric parameters) are connected to the criterion (the results in lead climbing) in a statistically significant manner, which makes it another factor of the lack of any statistical significance at the multivariate level. The significance of individual regression coefficients for the variables of body height, hand length, hand span and arm span indicate that these anthropometric parameters should also be taken into consideration when selecting young competitors (lower body height and hand length, and a greater hand span and arm span). Considering that to date many studies have proven the influence of strength and specific strength on the results in sport climbing (Binney & Cochrane, 2003; Wattts, 2004; Schweizer & Furrer, 2007; Stanković, 2009; Stanković, Joksimović, & Aleksandrović, 2011; Puletić, 2014), further research should focus on whether there are any significant connections between the parameters of hand length and hand span and the relative strength of the hand grip of sport climbers.

The regression analysis of the influence of anthropometric parameters on the results in lead climbing among the female climbers (Table 4) indicates that anthropometric parameters have no statistically significant influence on the results in lead climbing among female climbers both at the multivariate level ($p<0.8109$), and at the univariate level for all of the applied variables. These results, which indicate that morphological characteristics are not the dominant factor which influences the results in lead climbing, have been confirmed in the studies of Mermier et al., 2000, España-Romero et al., 2006, Mihailov et al., 2009, Tomaszewski et al., 2011 and Stanković et al., 2013.

CONCLUSION

Based on the obtained results one can conclude the following:

There is no statistically significant influence of anthropometric parameters on the results in lead climbing among male and female climbers at the multivariate level, or for the applied variables among the female climbers at the univariate level.

However, the analysis of individual regression coefficients indicates the significance of the influence on body height (p-value= 0.0205) and hand length (p-value= 0.0446) with a negative value, and hand span (p-value= 0.0314) and arm span (p-value= 0.0138) with a positive value among the male climbers. The significance of the individual regression coefficients for the variables of body height, hand length, hand span and arm span indicate that these anthropometric parameters should also be taken into consideration during selection of young competitors (lower body height and hand length, and the greater hand span and arm span). In addition, the issue of whether there is a statistically significant connection between the parameters of hand length and hand span and the strength of the hand grip and relative strength of the hand grip among sports climbers should be addressed in future research.

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UTICAJ NEKIH ANTROPOMETRIJSKIH PARAMETARA NA REZULTAT U TEŽINSKOM SPORTSKOM PENJANJU

Cilj ovog rada bio je da se utvrdi uticaj nekih antropometrijskih parametara na rezultat u težinskom sportskom penjanju kod muškaraca (N=15) i žena (N=15) sportskih penjača seniora, u 10 klubova iz Srbije. Za procenu antropometrijskih parametrara izmerene su: telesna visina, dužina ruke, dužina noge, dužina šake, raspon šake i raspon ruku, a rezultat u sportskom penjanju pretstavljala je ocena najtežeg popetog smera u periodu testiranja. Regresionom analizom utvrđeno je da ne postoji statistički značajan uticaj antropometrijskih parametara na rezultat u težinskom sportskom penjanju kod muškaraca i žena sportskih penjača na multivarijantnom nivou, kao ni kod svih primenjenih varijabli kod žena sportskih penjača na univarijantnom nivou. Međutim, značajnost pojedinačnih regresionih koeficijenata kod varijabli telesna visina, dužina šake, raspon šake i raspon ruku upućuju na činjenicu da prilikom selekcije mladih takmičara ne bi bilo loše obratiti pažnju i na ove antropometrijske parametre (manja telesna visina i dužina šake, a veći raspon šake i raspon ruku). Takođe, trebalo bi istražiti da li postoje značajne relacije parametara dužina šake i raspon šake sa snagom stiska šake i relativnom snagom stiska šake sportskih penjača.

Ključne reči: *antropometrijski parametri, sportsko penjanje*